

10/784, 553

Amendments to the Specification:

Please replace paragraph [0005] with the following amended paragraph:

[0005] In industrial production of the acrylic acid family, the produced acrylic acid family is purified so as to be appropriate for use purposes and demanded quality of the acrylic acid family. In production of the acrylic acid family, there is a possibility that ~~such as~~ by-products such as (e.g. maleic acid) (which are formed from propylene used as a starting material) and dimer acid (which is formed in the production process) may be contained as impurities in the produced acrylic acid family. Therefore, a purification step for removing these impurities is needed.

Please replace paragraph [0025] with the following amended paragraph:

[0025] FIG. 2 is a plan view illustrating the disposition structure of the equipment of the purification apparatus of FIG. 1.

Please replace paragraph [0027] with the following amended paragraph:

[0027] FIG. 4 is a plan view illustrating the disposition structure of the equipment of the purification apparatus of FIG. 3.

Please replace paragraph [0041] with the following amended paragraph:

[0041] Hereinafter, detailed descriptions are given about the apparatus and process according to the present invention for purification of the acrylic acid family. However, the scope of the present invention is not bound to these descriptions. And illustrations other than the

10/784,553

following illustrations can also be carried out in the form of appropriate modifications of the following illustrations within the scope not departing from the spirit of the present invention.

Please replace paragraph [0044] with the following amended paragraph:

[0044] Conventional arts for production of the acrylic acid family can be applied to basic arts for production of the above acrylic acid family members. ~~Such as~~ Conventional starting materials and reaction conditions will do if they are set in combination ~~of~~ with the conventional arts for production of the acrylic acid family so as to be appropriate for use purposes and demanded quality of the acrylic acid family.

Please replace paragraph [0045] with the following amended paragraph:

[0045] The acrylic acid family having been formed by reaction contains impurities such as unreacted starting materials, additives having been added during the reaction, and by-products involved by the reaction. The purification step is carried out with, for example, ~~such as~~ a stripping column, an azeotropic dehydration column, a low-boiling-material separation column, or a high-boiling-material separation column in order to remove the unfavorable impurities to thus obtain an acrylic acid family having high purity so as to be appropriate for use purposes and demanded quality.

Please replace paragraph [0049] with the following amended paragraph:

10/784,553

[0049] The distillation column performs the functions of receiving the supply of the liquid containing the acrylic acid family and then discharging the vapor or liquid containing the objective acrylic acid family for ~~the retrieve retrieval~~.

Please replace paragraph [0053] with the following amended paragraph:

[0053] The shape and size of the distillation column differ according to, for example, such as its inner structure, the treatment method, and the amount of the acrylic acid family to be treated. However, it is usually favorable that the outer shape of the distillation column is cylindrical. In the case where the outer shape of the distillation column is cylindrical, the outer diameter of the distillation column can be set favorably in the range of 0.5 to 6 m, more favorably 2 to 6 m. The height of the distillation column is favorably in the range of 2 to 40 m. The capacity of the distillation column can be set favorably in the range of 0.5 to 1,000 m³.

Please replace paragraph [0057] with the following amended paragraph:

[0057] If necessary, the piping can be equipped with, for example, such as a pump, a valve (e.g. a pressure regulation valve, a flow rate regulation valve, a check valve, a safety valve, a drain valve), a flow rate meter, or a thermometer.

Please replace paragraph [0058] with the following amended paragraph:

[0058] The distillation column is further equipped with, for example, such as a measuring instrument or sensor

10/784,553

for detecting the internal temperature or pressure of the distillation column. It is also possible that a pressurizing or pressure-reducing apparatus for adjusting the internal pressure of the distillation column is installed into it.

Please replace paragraph [0060] with the following amended paragraph:

[0060] To the distillation column, there can be supplied a polymerization inhibitor in order to inhibit the polymerization of the acrylic acid family. Examples of usable polymerization inhibitors include hydroquinone monomethyl ether (methoquinone), manganese acetate, copper dibutyldithiocarbamate, N-oxyl compounds, hydroquinone, phenothiazine, and other publicly known polymerization inhibitors. These polymerization inhibitors can be supplied from the column top or middle of the distillation column in, for example, the form added to such as the acrylic acid family, an azeotropic solvent, or water. It is also effective in the polymerization inhibition to cause a molecular-oxygen-containing gas (e.g. air, oxygen) to blow in from the column bottom or from a lower portion of each reboiler.

Please replace paragraph [0064] with the following amended paragraph:

[0064] Types such as multitubular type, spiral type, and plate type are known as the reboilers. Any type is usable. The multitubular type is favorable for preventing the formation and adhesion of the polymer in each reboiler. Of the multitubular types, those which have vertical type structures vaporized inside tube with vaporizing inside tubes are preferable.

10/784,553

Please replace paragraph [0068] with the following amended paragraph:

[0068] ~~Such as~~ For example, steam or a phenyl ether type heating medium (which is an organic solvent) is utilized as the heating medium to be introduced into each reboiler. The temperature of the heating medium is favorably in the range of 80 to 250.degree. C. The pressure of the steam can be set favorably at not higher than 0.6 MPaG, more favorably at not higher than 0.4 MPaG.

Please replace paragraph [0070] with the following amended paragraph:

[0070] The flow rate of the liquid to be treated is set favorably in the range of 1 to 3,000 m³/h. As to the circulation of the liquid to be treated or the vapor between each reboiler and the distillation column, both of forced circulation with, for example, ~~such as~~ a pump and natural circulation due to, for example, ~~such as~~ the own weight of the liquid to be treated or the rising power of the vapor are possible. Usually, it is favorable to utilize the natural circulation which can reduce the operation energy.

Please replace paragraph [0071] with the following amended paragraph:

[0071] At least two reboilers per one distillation column are set in parallel thereto. What is meant by ~~the~~ parallel is that an identical liquid to be treated is supplied in lots to the at least two reboilers and then reboil-treated with each of them. This is a technical conception which is opposite to the disposition of the at least two reboilers in series such that: an identical liquid to be treated is treated with one reboiler, and thereafter

10/784,553

the treated liquid is supplied to another reboiler and then further treated therewith.

Please replace paragraph [0072] with the following amended paragraph:

[0072] The at least two reboilers may be different as to, for example, such as type, size, shape, or treatment ability. However, the combination of reboilers of the same specifications enables efficient treatment, and besides, facilitates the production of the reboilers and their maintenance and care and is practical. The same specifications refer to equipment of which the basic shape and size are the same. Equipment of which the basic specifications are the same, but which has symmetrical structure, is also included substantially in the same specifications.

Please replace paragraph [0076] with the following amended paragraph:

[0076] If the positions where the liquid-retrieving pipes for supplying the liquid (to be treated) from the distillation column to the reboilers are equipped to the distillation column are also set so that the liquid (to be treated) can be retrieved equally from the distillation column, then, for example, such as the stagnation of the liquid (to be treated) in the distillation column and the bias of the temperature therein can be prevented. Specifically, similarly to the vapor-returning pipes, it is effective to lessen the difference between the height positions or widen the interposed angles or set the liquid-retrieving pipes in equal or symmetrical positions in the outer periphery of the distillation column.

10/784,553

Please replace paragraph [0086] with the following amended paragraph:

[0086] In the case where at least two condensers are used, the specifications of, for example, such as tube and shell portion can be set in almost the same ranges as those of the reboilers. In the case where only one condenser is used, its capacity is set so as to be larger than in the case where at least two condensers are used. Particularly the diameter of the shell portion is favorably set so as not to be larger than 3 m. In the case where the diameter of the shell portion cannot help being too large, the condenser also had better be used in a number of at least two.

Please replace paragraph [0093] with the following amended paragraph:

[0093] The reboiler is equipped in a number of at least two. Therefore, when the liquid to be reboil-treated is supplied from the distillation column to the reboilers, the liquid is supplied in lots to the at least two reboilers. Hereupon, it is favorable to equally supply the liquid to the at least two reboilers. Thereby the formation and adhesion of the polymer in the distillation column and the reboilers can be prevented, so that efficient reboiling treatment can be carried out. Particularly, the vapor being returned from the returning pipes of the reboilers to the distillation column can be prevented from forming the prevent channeling in the distillation column, so that the distillation treatment in the distillation column is well carried out. It is possible to make the at least two reboilers equally display their treatment abilities to thus enhance the total treatment ability, so that efficient reboiling treatment can be carried out.

10/784,553

Please replace paragraph [0097] with the following amended paragraph:

[0097] As a result, it is possible to extend intervals of such as between, for example, inspection and cleaning operation operations of the inside of the apparatus or omit them, and therefore it is possible to carry out a high-quality purification operation durably for a long time, and therefore it is possible to greatly contribute also to the enhancement of the efficiency of the production of the acrylic acid family or to the reduction of costs of the production of the acrylic acid family.

Please replace paragraph [0103] with the following amended paragraph:

[0103] The reboilers 30 have a function as heat exchangers for heat-boiling the liquid having been retrieved from the distillation column 10. As the reboilers 30, there are used those of which the entireties are approximately cylindrical and which have a multitubular type vertical structure vaporized inside tube with vaporizing inside tubes. The reboilers 30 receive the supply of the liquid from their lower end sides and then feed out the boiled liquid, that is, the vapor, from their upper end sides.

Please replace paragraph [0114] with the following amended paragraph:

[0114] In the distillation column 10, the vapor of the unpurified liquid rises. Depending on the difference between properties of components as contained in the unpurified liquid, the acrylic acid family as contained in the unpurified liquid rises to the top of the distillation column 10. However, impurities can rise only to the way and then falls so far and then fall. In the vapor having risen

10/784,553

to the top of the distillation column 10, the purity of the acrylic acid family is high, and the impurity content is low.

Please replace paragraph [0172] with the following amended paragraph:

[0172] An aqueous solution containing unpurified acrylic acid (containing acrylic acid 67.5 weight %, acetic acid 2.2 weight %, water 28.6 weight %, and the balance comprising, for example, such as maleic acid, acetoaldehyde, and acrolein, and hydroquinone 200 weight ppm) was supplied at 23.0 m.³/h from the feed pipe 12 to the 23rd plate of the distillation column 10.